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TANK CREW TRAINING PROGRAM OUTLINE FOR USAREUR UNITS

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by

Elmo E. Miller
General Research Corporation
7655 Old Springhouse Road
McLean, Virginia 22101

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Contracting Officer's Technical Representative
John F. Hayes, ARI Field Unit-USAREUR

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U.S. ARMY RESEARCH INSTITUTE
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An overview of a tank crew training program incorporating a tank analysis of tank crew functions and the results of research on the reported difficulties of tank crew members during training. The paper outlines major events during the annual training process; training on sub-tasks followed by debriefing techniques and overall evaluation of the M6A1AOS gunnery program.

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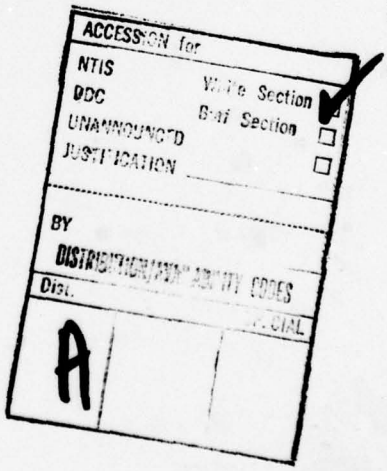

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TANK CREW TRAINING PROGRAM OUTLINE FOR USAREUR UNITS

INTRODUCTION

Tank gunnery training in USAREUR is undergoing several changes in direction. First, in response to a numerically superior ground threat, Table VIII, a criterion of tank gunnery performance, has incorporated multi-target engagements. Second, there is also to be sustainment of skill at a consistently high level, rather than the annual peaking and degradation of skill that have been characteristic of gunnery programs. Third, it is also necessary to decentralize training, because it is not feasible to bring crews to major training areas (MTA's) often enough to maintain the desirable skill level. Finally, effectiveness of training is to be achieved through performance-oriented training, in which instructional objectives guide the practice of component tasks until performance standards are achieved.

The first step in designing the program was a task analysis of tank crew functions[1] with respect to the revised Table VIII. The difficulties crews encountered on Table VIII, as disclosed in debriefing, were then investigated so as to focus the training on actual problems,[2] and the characteristics of feasible training methods and devices were derived from documents such as a recent review of scalar ranges and subcaliber devices by the Armor School and FM 17-12.

This paper outlines a tank crew training program that is designed to satisfy the above requirements. First the major events are presented. Then training on functional subtasks (fundamentals) is discussed. Finally, characteristics of effective debriefing are discussed, because debriefing is seen as a means by which crews can benefit the most from their testing and training experience.

SCOPE

This scope of this paper is limited to crew evaluation at the local training areas (LTAs) in USAREUR. The other events are mentioned only to put that testing in perspective. The evaluation program is to be limited to skills that are directly relevant to performance on Table VII, so as to be efficient preparation for events at the MTAs. It is recognized that the current Table VIII does not tap all gunnery skills required in

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[1] Miller, Elmo E. and Hayes, John F., "Analysis of Tank Crew Duties For Multiple Target Engagements," Research Memorandum Army Research Institute, Arlington, Va. 1977.

[2] Manthey, Gerald E. and Miller, Elmo E., "Tank Crew Gunnery Performance Problems Diagnosed in Debriefings," Research Memorandum GRC-OAD-CR-171, General Research Corporation, McLean, Va. 1977.

combat, and that it may change. In relation to known gunnery requirements, Table VIII is limited by practical constraints such as funds, terrain, and device technology.

It is also assumed that the crewmen being evaluated are more or less experienced, so the program does not cover elementary information and skills of indirect relevance (e.g., theoretical explanations). However, certain contingencies that happen only occasionally are covered (e.g., immediate action) if they are critical and reasonably likely to occur. Conditions for training are also discussed when they differ appreciably from the testing situation.

Evaluation at the LTAs is also to be a diagnostic program. In Table VIII itself the component skills are confounded so that it is often difficult or impossible to determine why targets are missed, and what kind of practice is needed. The program described here evaluates many subskills independently so as to determine what practice is needed. (Such independent evaluation is necessary also because the total performance cannot be simulated at the LTAs.)

The program is also limited to the M60A1AOS tank. Thus this program is to be only one module, albeit a model one, of an overall tank gunnery program.

ANNUAL TRAINING PROCESS

It is assumed that there are to be three major events at the MTAs each year: ARTEP once and tank gunnery (especially TABLE VIII) twice. ARTEP is to involve tank gunnery on a sampling basis only. The current Table VIII involves multi-target engagements. Table VIII and preparation would be a modified form of the annual Tank Crew Qualification Course (TCQC) so that it would be feasible to have two such events every year, rather than only one. It would involve Table VIII and various preparatory events at the major training area (MTA) including boresighting and zeroing as needed, a brief table involving machine gun targets, firing from a moving tank (stabilized, subcaliber) and Table VII. Practice with machine guns is needed here because it is not feasible at LTAs, nor is there any good simulation currently available. Similarly, firing from a moving platform, stabilized, is needed because it generally is not feasible at the LTAs. Table VII seems to be the minimal preparation needed to get accustomed to actual firing of the main gun and for integrating the performance of all subtasks. Both Tables VII and VIII would involve thorough debriefing.

Between the three major events at the MTA, there is to be qualification at the LTA (Simulated VIII) which is the best approximation of Table VIII skills available at the LTA. Simulated VIII (S8) is designed to be a diagnostic test as well as a practice event, so that crews may practice the specific skills they need until they qualify. Together, Simulated VIII and the events at the MTA involve six gunnery events per year, or one about every two months. Thus, the total program ensures sustainment of the critical skills.

COMPONENTS OF SIMULATED VIII

The activities of Simulated VIII are clustered at six stations for convenience of administration, as follows:

Station 1. Paper and pencil test (gunner and TC)

1. Estimation of lead
2. Adjustment of fire

Station 2. Stationary tank (gunner and TC)

1. Aiming at stationary targets
2. Tracking moving targets
3. Range card, applying data

Station 3. Full scale range, non-firing (all crew members)

1. Target acquisition
2. Laying main gun (approx)
3. Ranging

Station 4. Subcaliber range, 1/60 scale (crew, especially gunner and TC)

1. Daytime engagements
2. Night engagements

Station 5. Moving tank (all crew members)

1. Loading main gun
2. Immediate action, main gun
3. Immediate action, Cal. 50
4. Immediate action, Coax
5. Driver tactical response

Station 6. Moving tank range, 1/20 to 1/2 scale (all crew members)

1. Daytime engagements
2. Night engagements

Station 4 and 6 involve engaging multiple targets on scaled ranges and are the best simulation of the total tasks of Table VIII available at the LTA. (Appendix A is directed toward resolution of critical problems with the simulation of 1/60 scale ranges.) The other stations involve testing (and practice) of various functional subtasks (fundamentals). The functional subtasks are tested separately because some critical functions of Table VIII are not simulated on scaled ranges, and because testing and training on particular functions are more effective and efficient.

EFFICIENCY AND EFFECTIVENESS OF SUBTASK TRAINING

Tank gunnery is comparable to football practice, in which the fundamentals are practiced separately, then combined. Good teams spend substantial time on such fundamentals as blocking, tackling, punting and running. After a player learns to make a hard clean tackle on a dummy (for instance) then he is ready to practice tackling in scrimmage (that is when he meets the criterion for the functional subtask). Later, various individual and group skills are employed in a game. Each kind of practice has its unique advantages.

In tank gunnery, practicing the subtasks is <u>efficient</u> both in terms of time and of facilities required. For instance, a gunner can practice laying the reticle on a target image at a rate of several targets per minute, whereas he would have to wait for long periods between engagements on Table VIII, or even on scalar ranges, as a rule. Note that such subtask practice requires only the simplest facilities. Of course, that is not to say that he should continue such practice when he no longer needs it, i.e., after meeting the standard.

Practicing the functional subtasks is <u>effective</u> because knowledge of results is specific to a particular action of a particular individual. In other words, the learner knows that it was his action, and no one else's that caused the effect, and he knows precisely what he could do to correct any error.

In live firing on Table VIII, if a stationary target is missed, it is not readily apparent whether the gunner made an error in aiming, or whether the TC made an error in ranging, or whether one of the mechanical systems was out of adjustment. (That is why intensive debriefing is needed.) But when the gunner practices laying the reticle on a target image separately as a subtask, he knows that any error is his alone, and he knows how to correct it. Or when the TC practices ranging on a full scale range, he knows that any discrepancies between his data and the measured distances are attributable to his skill or his equipment. If the TC consistently makes excessive errors in ranging, then the problem must be analyzed further into mechanical problems (including adjustment and purging of optics), or insufficient practice, or perhaps poor visual acuity. Thus each of the functional subtasks may be analyzed into even finer functions, like the way the total performance of engaging targets is analyzed into likely causes during the debriefing process.

Note that the clean separation of functional subtasks depends upon the mechanical systems involved. The gunner's control and the TC's range finder (RF) control, taken together, determine the direction of the gun tube. Other actions during engagement may distract or help them, but do not directly affect accuracy (with the rare exception of certain gross procedural errors, such as loading the wrong ammunition).

It is desirable, of course, to integrate the subskills in total team performance. But mastering the subskills separately should not interfere with total performance, but rather enhance it.

MOTIVATION

It might be supposed that practicing subtasks would not generate as much interest and enthusiasm as firing service rounds or even subcaliber firings. That is likely to be true, but the adverse effects can be minimized.

First it is critical that objective performance measures be devised, and that training be conducted to standards. That provides a clear goal for the trainees, and eliminates dull repetition for those who do not need it. It also provides the information by which training managers can evaluate and control training, and, when necessary, they can insist upon the needed amount of repetitious drill. Perfection of any skill takes considerable practice, and one should not shy away from that fact.

SIMULATED TABLE VIII: PROGRAM OUTLINE

Each crew or specified crew member must meet each standard at every station in order to qualify. (Validation of the program is discussed in Appendix B, and alternate scoring systems are presented in Appendix C). Remedial training may be needed, and retesting is required until standards are met. It is desirable to pass tests at stations 1, 2 and 3 before attempting tasks on ranges (stations 4 and 6), especially for relatively inexperienced crews, because functional subtasks should be mastered before testing on the more comprehensive performances.

STATION 1. (NO SPECIAL ENVIRONMENT)

These are perceptual tasks which involve estimation of where the intended point of aim should be, without requiring the manual performance of tracking and firing. This allows one to determine perceptual judgment independently of manual skill, which is more efficient in terms of simulation facilities for testing, and gives more specific indication of needed training.

Part 1. Estimation of Lead on Moving Targets.

The gunner and TC independently indicate where to hold reticle in tracking a moving target (T62) in order to hit center of mass.

Simulation. Twelve target drawings (to scale) will each include a T62 and M32 reticle on center of mass.

A minimum of two alternate forms of the test (different random orders) shall be provided. The TC or gunner will draw a "+" to indicate the desired aiming point in tracking.

Specification of objective.

Subtask: Estimate lead from center of mass.

Conditions: Targets are assumed to be traveling at medium speed (13 m.p.h.). Drawings will represent two distances (1000 and 2000 meters), three angles of approach (30^{o}, 60^{o}, 90^{o} from line of sight) for both left and right. (HEAT ammunition is assumed.)

Standards: No more than one error of estimate exceeding 25% of largest lead at that distance. Total time: 60 seconds.

Administration. By groups. An overlay with cut out portion indicating tolerance zone will facilitate objective scoring.

Training. Diagrams illustrating the correct answers should be available for training.

Criticality. Although this skill is needed for holding a lead on moving targets, only rough estimates are needed. The necessary degree of skill should be easy to attain with minimal instruction.

Part 2. Adjustment of Fire.

The gunner and TC independently indicate the correct view of target and reticle after making specified adjustments according to the burst-on-target, target form and mil change methods.

Simulation. Each item will be a scale drawing of initial sight picture (T-62 and reticle) with burst on target (BOT) or spoken command indicated. The TC or gunner will draw a "+" to indicate aiming after adjustment. A minimum of two random orders shall be provided for the test.

Specification of objective.

Subtask: Demonstrate burst-on-target, target form, and mil change methods of adjustment.

Conditions: Four BOT items shall represent the four quadrants, two at 1000 meters and two at 2000 meters. Four "mil change" items shall also represent these quadrants and distances. Four "target form" items will involve drop 1/2 TF, add 1/2 TF, drop one TF, and add one TF; half shall represent a range of 1000 meters, and half 1500 meters. (Total, 12 items.)

Standards: 11 out of 12 within one mil tolerance.

Administration. By groups. An overlay with a cut out portion indicating tolerance zone (one mil radius) will permit objective scoring.

Training. Experienced crewmen are likely to pass this test, but occasionally an explanation will be needed.

Criticality. The necessary concepts can be mastered readily, but occasionally they are misunderstood.

STATION 2. STATIONARY TANK

Only short target distances are involved (55'). The station should be outside to provide the needed level of illumination (to compensate for the aperture that is required for focusing at these distances).

Part 1. Aiming, Stationary Targets.

Ideally, a gunner should bring his reticle on the target in a consistent motion, making the final adjustment upward (against gravity). It should be rapid at first, then settle smoothly onto the target without overshooting.

Simulation. A target board shall provide 40 scale drawings on a reflective background (scotchlite) to register laser hits. The target sequence is to be indicated by a line connecting successive targets, with each target within the infinity sight when the previous target is engaged. Intended point of aim is to be indicated by a dot on center of mass with a tolerance oval to facilitate scoring.

The scale drawings are to be 1/60 scale at 55 feet (simulating a range of 1000 meters). (These could be the laser targets now in production, attached to a target board). An M55 laser is to be mounted on the main gun (using a Brewster device or similar mounting) adjusted to coincide with the M32 sight optics at the distance of the target board. The laser is to be left on during aiming to facilitate scoring from outside the firing tank.

If the M55 laser should prove impracticable for this application, simpler alternatives should be developed for this most critical skill. Almost any projection device would suffice (e.g., a flashlight and lens that projects an arrow) if it is mounted with the main gun, and adjusted to coincide with the M32 sight reticle at the range of the target board. Or the laser could be used in a pulsed mode if another observer checked on technique by watching movement of the main gun.

Specification of objectives.

Subtask: Aim main gun at stationary tank targets (40).

Conditions: Each target within infinity sight when reticle is on previous target. Direction of adjustment from previous target will include up, down, left and right in approximately equal proportions, in random order. Aiming point indicated by dot.

Standards: Accuracy, 38 out of 40 within tolerance oval (one mil high, 1.5 mils wide, centered on aiming point). Time, three seconds per target, average. All targets approached upward, 36 out of 40 with no overshooting.

Training. The same arrangement is effective for training as for testing.

Criticality. Since almost all targets on Table VIII are engaged with both target and platform stationary, this skill is most critical to accuracy. Therefore, the standards are stringent, so it may take considerable practice for some gunners to meet them.

Part 2. Tracking Moving Targets.

This skill applies estimation of lead, along with manual control skill.

Simulation. A 1/60 scale model target is to be towed across the field of view at a distance of 55 feet by a cable and motor. Medium speed (13 mph) is to be simulated. (The motor, tank and cable arrangement can be the same kind that is used on the 1/60 scale range.) An M55 laser is to be mounted and aligned with the M32 sight reticle at that distance. A tolerance oval of reflective material is affixed to the model to facilitate scoring.

Specification of objective.

Subtask: Gunner tracks and fires at moving target.

Conditions: Tank target moving at medium speed (13 mph scale) crossing obliquely (about 5^{o} from the horizontal). Of 30 targets, 10 shall move downward left, 10 downward right, 5 upward left, and 5 upward right. (HEAT ammunition is assumed.)

Standards: 25 out of 30 within tolerance oval 2 mils high, 4 mils long, centered on correct point of aim.

Training. The same arrangement can be used for training. A "snakeboard" also may be used for basic manipulatory skill, but it differs from moving targets in being a self-paced task, so practice with moving targets is also needed. Gunners may also practice tracking without firing the laser. This is convenient because the procedure does not require another person to observe, and also because several tanks can simultaneously track a moving target. But tracking moving targets is not quite the same thing. Firing also involves timing the trigger to coincide with the best moment, so some practice with actual firing should be provided as an advantaged stage.

Criticality. Although moving targets are involved in only two of the engagements of Table VIII, tracking is one of the most difficult skills, so this subtask should present a challenge to gunners. Also, targets in combat are very likely to be moving, so Table VIII probably under-represents movement (because of practical difficulties in moving target mechanisms).

Part 3. Range Card Data.

Simulation. Stationary tank.

Specification of objective.

Subtask: Apply range card data.

Conditions: Range card with representative data.

Standards: Data correctly applied within 25 seconds.

Criticality. This subtask involves a rather simple procedure. However, it provides a convenient way to check the crew's application of range card data, without the time-consuming process of actually moving into position.

STATION 3. FULL SCALE RANGE (Non-Firing)

All crews members participate at this station. A field of view covering at least 2000 meters from the observer tank is required.

Part 1. Target Acquisition.

Simulation. Ten targets representative of types and ranges encountered in Table VIII are to be distributed tactically around a viewing position. They are to be constructed so that they can be exposed in two groups of five each. All crew members are involved, and are to be in their positions in a tank. To facilitate recording of targets detected, each crew member is to be given a line drawing of the terrain, and he is to make a dot wherever he detects a target.

Specification of objective.

Subtask: Detect targets and record location.

Conditions: Two target groups, five targets each group, are exposed for 40 seconds each. TC may assign search sectors to crew members in any tactically realistic manner.

Standards: 8 out of 10 targets detected and recorded. Crew is credited with any target than one or more crew members record.

Administration. Crews shall be retested as necessary to meet the standards. The testing may also serve as training by having feedback available.

Training. Alternate sites with varying terrain are desirable for training. At a minimum the practice targets must be different from the test targets. It is imperative during practice that the participants actually respond and get feedback on their performance. In the feedback the crew should be shown the targets they missed as well as the targets they got correct. It is active responding and feedback that most distinguishes the prescribed training from traditional, boring "detection" training in units. One would expect substantial gains from practice because of the complexity and perceptual difficulty of this skill.

Criticality. Target acquisition will become increasingly critical to Table VIII as pop-up targets are instituted. It is likely to be even more critical on the modern battlefield. Every increment of ability would be useful tactically right up to the limits of visual acuity.[3]

Part 2. Ranging (Using Rangefinder).

Simulation. Twenty full-scale tagets will be distributed at ranges from 1000 to 2000 meters with varying degrees of sharpness of outline (but no sharp vertical edges, like bracing timbers or numerals). Test administrator, acting as gunner, places reticle on each target. The test may use the same terrain and targets as for target acquisition. The TCs own tank is to be used.

Specification of objective.

Subtask: TC determines range to targets with rangefinder.

Conditions: 20 targets at ranges of 1000-2000 meters.

Standards: Average error, 50 meters or less. Average time per target, four seconds from the time TC announces he is ready until adjustment is complete.

Administration. One person who is thoroughly familiar with targets and terrain is needed in gunner's seat. Other personnel may be needed to manipulate targets. This function is not involved elsewhere at the LTA. If the TC cannot perform to standard on this task, several possibilities should be considered. There might be an equipment problem, such as mechanical adjustment or purging of sights, and that should be investigated. (The TC should use his own tank for this test.) Or the TC may need more practice. Finally, the TC may lack the basic visual acuity needed for this task. Poor visual acuity seems likely for some TCs because of the absence of visual screening standards.

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[3] China Lake study.

Training. If it seems likely that practice is needed, the testing situation would also be used with minor modifications in method. On each target, the TC would range, and the correct range would be announced. He should then range again on that target, repeating the motion until he can range exactly and is satisfied that he is thoroughly familiar with the look and feel of correct ranging on that target. Consistent technique is desired. He would do the same for each subsequent target. The TC should pay attention to the way his experience varies with different ranges. He would repeat the cycle until he is consistently within the tolerance specified.

The Stout device has been suggested for testing this function, and it also involves the gunner's aim. But there should be independent scoring for gunner and TC, as well as hit or miss data. The Stout device also requires additional setup and adjustment of equipment, so that generally the TC finds it infeasible to use his own tank. Therefore, the device does not appear a good choice for the testing program, although it may be a useful alternative for practice.

Criticality. Ranging is a most critical skill, because it is the only perceptual-motor skill, besides aiming, that directly affects accuracy. (Certain procedural, or discrete, steps also affect accuracy, e.g., what ammunition is indexed in the computer, but these actions can be learned quickly with minimal fidelity of simulation, and they do not in fact cause errors nearly so often as aiming and ranging.) Also, there appears to be no other effective way to practice and test this skill. The TC needs specific feedback on this particular function, rather than the skill being confounded with the gunner's aim, as it is with firing at targets. The TC needs to know the measured distance to targets.

Part 3. Rough Lay of Main Gun.

Simulation. Twenty tank targets shall appear at about 1000 meters range dispersed so as to require substantial adjustment of the gun between targets. They shall be readily identifiable, e.g., large code letters beside each target. The gunners' infinity sight shall be used to score performance.

Specification of objective.

Subtask: TC lay main gun (approximately).

Conditions: Each target indicated. Each target displaced 5-30^{o} in azimuth, 3-15^{o} in elevation from previous target, with direction random.

Standards: Fifteen out of 20 targets have some part in the circle of the infinity sight. Performance begins when TC starts to slew gun tube. Three seconds per target, average.

Administration. One test administrator sits in gunner's seat. This skill is involved in performance on the scaled ranges at the LTA (stations 4 an 6). If the TC does not meet the standards, he should practice and be retested until he does.

Training. Training can be conducted in the same situation as testing, with minor changes in method. After making his initial lay, the TC should get feedback by looking through his range finder, or by having the gunner indicate exactly where the target is in the infinity sight. The TC should readjust the gun tube until he has it centered on his reticle. Then he should study its appearance in relation to the target when correctly laid.

The skill may also be practiced almost anywhere outside, using any identifiable terrain feature as a target. But the terrain feature should not be closer than about 500 meters, because of parallax.

Parallax makes this a much different skill at very close ranges. For instance, on a 1/60 scale range, if a target is projected to full scale and the gun laid accordingly, the target may appear completely out of the infinity sight instead of being within the circle. If the TC's viewing position is one meter above the infinity sight (vertical parallax) that would make only one mil difference at 1000 meters, but 60 mils difference on a 1/60 scale range.

Therefore, this skill should be practiced with rather distant targets. Also, if a TC does not understand and compensate for this parallax, there is apt to be negative transfer of training (interference) between 1/60 scale and full-scale ranges.

Criticality. Failure to perform this function accurately during engagements could result in extremely slow performance if the gunner cannot see the target. It is important to practice this as a subskill because it is a rather difficult skill to learn (involving complex perceptual judgment) and because poor performance during engagements might be blamed erronously on the gunner. Also, in the complete task the feedback may be misleading, because the gunner's announcing "identify" may lead the TC to think that the gun is approximately on target, when in fact it may be in the periphery of the infinity sight.

STATION 4. SUBCALIBER (1/60 Scale)

The following are the engagements of Table VIII, with standards and conditions adapted to apply to particular engagements with 1/60 scale ranges. All ranges and speeds are to scale.

Part 1. Daytime Engagements.

Simulation. A 1/60 scale range shall provide popup targets, controllable remotely (main gun targets only).

Specification of objectives.

Task 1. Engage multiple machine gun targets (troops, BRDM) with both the coax and the cal. 50 during daylight. (Not simulated on 1/60 scale ranges.)

Task 2. Engage multiple (2) moving tank targets with the main gun during daylight.

Conditions.

(1) Targets: One tank panel (flank) moving perpendicular to the line of sight. One tank panel (frontal) moving directly toward or away from firing tank. Both concealed before engagement, with movement started simultaneously. Range 11-1400 meters, speed 10-15 mph.

(2) Ammunition: 3 rounds allocated.

(3) Initiation of engagement: Upon command of platoon leader, or activation of popup target.

Standards for each engagement.

(1) Time. Open within 8 seconds.

(2) Effect. Both targets hit.

Task standard. Two successful engagements out of three.

Functional Components[4]

Target acquisition

Main gun: BS or precision

Task 3. Engage multiple (2) tank targets with the main gun and one BRDM with Cal. 50 during daylight.

Conditions.

(1) Targets. One tank panel (frontal) at 1400 meters. One tank panel (frontal) at 1900 meters. One truck (without missile capability) at 700 meters. The truck is to be engaged as a dry firing exercises with the Cal. 50 in conjunction with engagement of the other targets. All targets will be concealed prior to engagement.

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[4] After each engagement task the functional components (subtasks) are referenced. These are described in the task analysis, and hence are not repeated here.

(2) Ammunition. 3 rounds allocated.

(3) Initiation of engagement. Upon command of platoon leader or activation of popup target.

Standards for each engagement.

(1) Time. Open within 8 seconds.

(2) Effect. All targets hit.

Task standard. Two successful engagements out of three.

Functional Components.

Target acquisition

Main gun: precision

Part 2. Night Engagements.

Simulation. Same as for daytime, except searchlights and IR illumination are needed.

Specification of objectives.

Task 1. Engage one stationary tank target with the main gun utilizing the range card to direct lay technique, at night under direct white searchlight illuminations.

Conditions.

(1) Target. One tank panel (frontal) selected from seven or more, distributed at ranges of 10-1200 meters. These will be represented on prepared range card.

(2) Ammunition. 2 rounds allocated.

(3) Firing tank moved into prepared, staked position prior to engagement.

(4) Initiation of engagement. Preparatory phase (in which data are applied to the fire control system) is initiated when prepared data for one target is given and upon command. (After the data are applied to the gun, the TC reports to the platoon leader.) The engagement itself is initiated when searchlight is turned on the target tank.

(5) Other. All hatches will be closed and crew members will wear protective masks 30 seconds prior to and during engagement.

Standards for each engagement.

(1) Time. Data applied within 25 seconds. Open within 5 seconds of illumination.

(2) Effect. Target hit.

Task standard. Five successful engagements out of six, with two first round hits.

Functional Components

Target acquisition

Main gun: precision

Firing from range card

Special environments, NBC, buttoned up.

Task 2. Engage one stationary tank with the main gun, utilizing the range card to direct lay technique, at night under direct IR searchlight illumination.

Conditions.

(1) Target. One tank panel (frontal) selected from seven or more, distributed at ranges of 10-1200 meters. These will be represented on prepared range cards.

(2) Ammunition. 2 rounds main gun for each engagement.

(3) Firing tank moved into prepared, staked position prior to engagement.

(4) Initiation of engagement. Preparatory phase (in which data are applied to the fire control system) is initiated when prepared data for one target are given and upon command. (After the data are applied to the gun, the TC reports to the platoon leader.) The engagement itself is initiated when IR light is turned on the target tanks.

Standards for each engagement.

(1) Time. Data applied within 25 seconds. Open within 5 seconds of IR illumination.

(2) Effect. Target hit.

Task standard. Five successful engagements out of six with two first round hits.

Functional components.

Target acquisition

Main gun: precision

Firing from range card

Task 3. Engage multiple maching gun targets (troops, BRDM) with both the coax and the Cal. 50 at night. (Not simulated on 1/60 scale ranges.)

Task 4. Engage multiple (2) moving targets with the main gun at night.

Conditions.

(1) Targets. One tank panel (flank) moving perpendicular to the line of sight. One tank panel (frontal) moving directly toward or away from firing tank. Both at 11-1400 meters, speed 10-15 mph, under direct illumination by searchlight.

(2) Ammunition. 3 rounds allocated.

Task standard. Two successful engagements out of three.

Functional Components.

Target acquisition

Main gun: BS or precision

Administration. For qualification on Station 4, a crew must meet the standards for two out of three engagements in Part 1 (daytime) and two out of three engagements in Part 2 (night).

If a crew does not qualify at first, their difficulties should be diagnosed in a brief conference with the crew (the debriefing process is discussed more fully in a subsequent section). In this process, an experienced tanker who is accepted by the crew (such as the platoon sergeant or a master gunner) should discuss their problem areas with them in order to help them qualify upon retesting.

One of the first things to consider (when a crew does not qualify) is the possibility that they may lack one of the basic skills, which would be indicated by failure on one of the subtasks at the earlier stations (Stations 1 and 2, Part 3 of Station 3). Then one should determine whether the particular deficiency would explain the results on the range. For instance, if the gunner did not pass aiming, stationary targets, that might explain general inaccuracy over several engagements. In such cases, the basic skill should be mastered first, before retesting is attempted on the subcaliber range.

One might infer certain deficiencies from the pattern of results on the various engagements. Thus, one might identify difficulties with moving targets only or in night operations, or under NBC conditions. However, such diagnoses should be tentative, because of the unreliability of patterns of scores. Any chance factors on particular engagements are compounded when patterns of scores are considered.

The statistical reliability of target hit/miss data on a small number of rounds (as involved in the typical engagement) is somewhat questionable; that is to say, one is fairly likely to fail a standard one time and meet it the next. Therefore, simply repeating the test may be the best procedure, especially if the crew easily met the standards on other engagements. Statistical unreliability is especially likely if the subcaliber device chosen has a rather large dispersion pattern.

A special problem that may impact on performance on 1/60 scale ranges is the parallax involved in the TC's rough lay of the gun, as noted above. This may cause some delay in the gunner's identifying the target. If the TC merely projects the scale target to the simulated distance, then the target will appear to the gunner considerably above and to the right of the circle in his infinity sight. Both gunner and TC should be aware of this factor in laying the gun tube, or else there is apt to be interference in skill between 1/60 scale range and full-scale operations.

STATION 5. MOVING TANK FACILITY

The whole crew is to be present while tank moves at moderate speed on a road of moderate roughness. A monitor rides with them to score the subtasks. (Part 1 only, tank is stopped.)

Part 1. Loading Main Gun.

Subtask: Load main gun five time (unload between).

Conditions: Dummy round, open breech, stationary tank.

Standard: 30 seconds.

Criticality. In extended firing exercises, it has been observed that speed of reloading is the limiting factor in rate of firing, and that it often drops precipitously after the first two or three rounds. This is a test not only of skill but of stamina. In simulation of combat, it would be desirable to have a much longer sequence, but five rounds in rapid succession is all that can be justified in preparation for the current Table VIII. Perhaps a test of extended loading should be added to Table VIII. The unloading requirement in this test compensates somewhat for the shortness of the sequence, as well as being a practical necessity.

Part 2. Main Gun: Immediate Action.

A dummy round is needed.

Subtask: Apply three triggers, rotate the round and attempt to fire again.

Conditions: Assume initial misfire, no hot tube.

Standards: 15 seconds.

Part 3. Caliber .50 Immediate Action.

Subtask: TC will recharge weapon and attempt to fire it.

Conditions: Assume weapon does not fire.

Standard: 5 seconds.

Part 4. Coax Machine Gun: Immediate Action.

Subtask 1: Loader will recharge weapon and gunner will try again to fire it.

Conditions: Assume stoppage.

Standards: 5 seconds.

Subtask 2: Secondary corrective action. Loader will charge the weapon, lift the cover, check the feed tray, use extraction tool to remove jammed round, close cover. Gunner will try again to fire it.

Conditions: Immediate action (above) does not reduce stoppage because of jammed round.

Standard: 25 seconds.

Subtask 3: Change barrels. Loader will change barrels on the coax.

Conditions: Assume that above actions do not remove stoppage or that there is a hot barrel.

Standard: 5 seconds.

Subtask 4: Loader will disassemble and assemble the coax machine gun, locating any malfunction.

Conditions: Assume coax that does not fire and does not clear with recharging and attempted refire.

Standards: 4 minutes.

Part 5. Driver Tactical Response.

This test is restricted to those driver responses involved in Table VIII, which are minimal. Other driver skills may also be conveniently tested at this time, but those are beyond the scope of this paper.

The TC should have an agreement on the responses he wants the driver to make on the engagements in Table VIII, without requiring explicit directions to the drive (e.g., "Come to a smooth stop unless I give orders to the contrary.") The TC shall have this agreement in written form to give to the examiner, for judging the appropriateness of driver response.

Preliminary arrangements should also include selecting terrain permitting defilade on two engagements.

Subtask: Driver responds to commands for the eight engagements of Table VIII according to a pre-arranged schedule. On two engagements he will utilize available defilade.

Conditions:

(1) Verbal command to gunner.
(2) Pre-arranged responses.
(3) Defilade available for two engagements

Standards:

Correct and timely responses.

STATION 6. MOVING TANK RANGE

This activity is to use the largest scale range available at the LTA, which generally will be 1/20 to 1/2 scale. The M55 laser will simulate the main gun. The firing tank will move between engagements, and tactical dispersion of targets will be more realistic than on the 1/60 scale range. The tasks, conditions, standards and administrative arrangements will otherwise be the same as on Station 4.

The detailed arrangements for this station have yet to be determined, so it is important to focus on those aspects that are not elsewhere simulated. The critical aspects of this activity are the various procedural elements of engagements, including moving, stopping, switch positions, and crew coordination. If there must be compromises between the procedural aspects and simulation of firing, the procedural considerations should receive priority, because firing is simulated on the subcaliber range (Station 4) and in various functional subtasks (especially aiming and ranging).

Training

The essential function of the moving tank range is to ensure mastery of procedures, and efficient training of procedural skills involves special training methods. These methods often are not realized, resulting in gross inefficiency and failure to achieve the desired proficiency within existing constraints.

Initially, each engagement should be practiced in a stationary tank to get the rudiments of performance, including communication, switch positions and general conduct of the engagements. The reason is that these conditions allow several times as many repetitions per hour as a moving tank. For this initial practice, it is suggested that the target configuration for each engagement should be simulated by a target board with 1/60 scale targets at 55 feet (like Station 2, part 1). The firing tank should initially have its main gun pointing about 90° from the targets, and be required to slew to engage the targets. Seven seconds should be allowed for the first round on each target, and four seconds for each subsequent round. Firing could be simulated by pulsing the M55 laser. All essential procedural steps should be required, e.g., taking the main gun off safety and indexing the right ammunition. When the crews can do this reliably, they should go on to practice the engagements while moving. Even some "overtraining", i.e., beyond the point of apparent mastery, is desirable, in order to prevent forgetting.

The practice in a stationary tank should require very few training hours, even though each engagement is repeated many times. Procedural practice, involving both stationary and moving platforms, is the primary tool for fast opening times.

It has been demonstrated that time to open almost doubles in the offseason between annual gunnery events.[5] Although this degradation is sometimes attributed to not firing recently, it is probably more accurate to say that the slowdown is a result of not practicing in preparation for firing. From research and experience with procedural skills, it would appear that the critical experience for speed is repetitive practice, not the few minutes of actual firing. The difference is critical, because tank crews and their officers often despair of maintaining speed when they are able to fire only once or twice a year. But speed can be maintained quite simply by training to standards on procedural criteria, without actual firing. This is not to say that live fire gunnery should be conducted less often. Actual firing is necessary for integration of part-task experiences (including noise and recoil) and to check performance of the total system. But is is possible to maintain the necessary specturm of skills under existing constraints.

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[5] Total Tank System Study Group, Simulation, TRADOC, Ft. Monroe, VA., July 1976, p. 11.

DEBRIEFING[6]

In order to improve, each crew member needs to know how his actions contributed to tank gunnery performance. The complexity of performance on Table VIII often makes it difficult to determine what factors account for missing targets or firing late. No single person can observe all the relevant events. Outside observers do not observe what happens within the tank. Each crew member gets an incomplete picture. Debriefings have the potential of assembling the available evidence for diagnosing deficiencies as a basis for subsequent improvements.

USES OF DIAGNOSTIC INFORMATION

Diagnostic information may be used either by the crews themselves, or by other crews that are likely to have similar problems. The crews themselves can concentrate their practice on deficiencies, and perhaps change their technique if it is faulty. Their commanders can use diagnostic information to allocate training time and facilities on the basis of need. Other crews could use the diagnostic information to prepare for Table VIII; this function might be facilitated by a newsletter from the MTA describing current problem areas. For example, some crews currently are using unorthodox "battlesights" techniques, which are associated with low hit probabilities.

The diagnostic information may also be used by program administrators to change practices for training and testing of tank gunnery. If crews have trouble with a particular aspect of the course, the training program may be modified by changing standards or conditions on a corresponding subtask. For example, if gunners are having trouble hitting moving targets on Table VIII even after meeting the standards on Station 2, Part 2 at the LTA the tolerance zone (for the subtask) might be reduced in size, or the number of hits required might be increased, or some other condition might be imposed to increase realism. Debriefing information might also be used to change conditions on Table VIII. For example, some crews are missing range card engagements because the target is not illuminated, which indicates a need for better preparation of crews manning searchlights. Also (more seriously) crews are able to determine in advance the exact location of all targets, thus virtually eliminating the requirement for realistic target acquisition.

Debriefing information, it should be noted, must be treated confidentially in certain respects, or else crews will be reluctant to discuss their problems. Information from particular crews should be used to help them, not to punish them. Summary information should be handled so as not to reflect adversely upon particular units, to ensure their continuing cooperation.

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[6] The process is described more fully in the report cited above, by Manthey and Miller.

OCCASIONS FOR DEBRIEFING

Debriefings should be conducted throughout the training and evaluation process, whenever the factors affecting gunnery performance are not readily apparent to everyone involved. Sometimes a few questions will reveal the problem, and sometimes more thorough probing will be needed. Occasionally even performance of functional subtasks at the LTA will warrant a brief discussion. For instance, if a gunner is having difficulty aiming at stationary targets (Station 2, Part 1) a discussion with a highly experienced tanker may reveal that he is using an awkward grip or holding the control too tight. Similarly, performance on the scaled ranges might require a brief discussion. But all performances at the LTA are much simpler than Table VIII, and hence easier to diagnose.

Both Tables VII and VIII are opportunities for thorough debriefing. The debriefing after Table VII offers the best opportunity to discover any deficiencies in total performance before undergoing Table VIII for the record. But crews are most anxious just before Table VIII, and time for remedial action is severely limited. But some problems, including adjustments and maintenance, should be remedied if possible. Many crews complain of lacking opportunity to fix mechanical problems that they know about before Table VIII.[7] After Table VIII the crew is somewhat more relaxed, but motivation is somewhat lower because they cannot affect their scores on that MTA event. Also, since Table VIII is considered a "final exam", there is no denying its importance to the crews, and any shortcomings are likely to be taken seriously.

PEOPLE INVOLVED

The debriefer should be someone thoroughly knowledgeable in tank gunnery so that he can interpret the evidence. He should also be skilled in using probing questions to elicit information. The gunner and TC are the critical crew members, and the loader and driver should attend to prepare them for promotion, as well as to discuss their role in the engagements.

TECHNIQUE

The objective in debriefing is to analyze performance to account for missing the target or other deficiencies, and to determine what could be done to improve performance on future occasions. The evaluation data (including hits, sensings, and time) serve as a starting point, but should be considered as facts to be explained, and <u>not</u> the objective. However, debriefers that we have observed almost always limit their discussion to presenting the evaluative data, so definite steps must be taken to reorient debriefers if they are to achieve the desired results.

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[7] op cit.

A diagnostic debriefing must also consider events observable only by crew members, e.g., the sight reticle view, in explaining the performance. If the crew is involved in the diagnosis, they also are more likely to accept interpretations of their shortcomings.

Particular debriefing techniques may be derived from the objective of explaining deficiencies in performance. The place should be reasonably quiet and comfortable. The debriefing should be conducted soon after the event, so that details are not forgotten.

A standard recording form can structure the situation and focus attention on the kinds of information needed. The form also should make it easier to summarize information on many crews than with narrative description. But the form should not be so detailed that it dominates the discussion by focusing attention on the form rather than on the crew's problems. It should be simple enough so that it is easy to learn to use. It should follow a chronological sequence of events, beginning with conditions that existed at the start, e.g., misaligned optics, and proceed engagement by engagement, target by target, round by round. For each round, information should be obtained in the following sequence: (a) what the tank system did, as recorded by the evaluator, (b) what the crew members did, e.g., the gunner shows where he aimed, demonstrating with a reticle pattern on a plastic overlay, and (c) probable cause of deficiencies and what skills need practice. On the second round, crew action would include a method of adjusting fire. A prototype developed in this project is included as Appendix D.

The debriefer needs to develop a style that is clearly mission-oriented as he probes for relevant information. That attitude is neither authoritarian nor permissive. If he is authoritarian, he is apt to give information, rather than eliciting it. If he is permissive, he is apt to abandon a line of questioning whenever the situation becomes uncomfortable because of conflict among participants or because of a need to admit shortcomings. Mission orientation is a leadership skill needed in many situations, not one that is peculiar to debriefing.

After performance problems have been diagnosed, remedial measures should be formulated. This generally will involve more practice, but it may also involve other action, e.g., better maintenance. The crew needs to know their shortcomings, but also their unit may need the information in order to allocate training time and resources. For some other kinds of problems, the unit may have to determine whether to hold the crew responsible, or whether to make other kinds of changes, e.g., when a crew blames malfunctions on availability of maintenance facilities or personnel, it should be decided whether it is merely a case of "passing the buck".

APPENDICES

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APPENDIX A POTENTIAL PROBLEMS WITH 1/60 SCALE RANGES

The most basic function of the simulation is to provide feedback to the crew, especially the gunner. The bare minimum is qualitative feedback: the simulation should register a hit when the service round would hit, and a miss when the service round would miss. There would also be some advantage in having quantitative feedback during training; that is, accurate information about the direction and magnitude of error, so that the gunner can adjust his technique accordingly. The quantitative feedback in tank gunnery is provided mostly by the sight picture, which is confirmed by hit or miss data.

PARALLAX

Since 1/60 scale targets are very small virtually no parallax can be tolerated. (Parallax is defined as the offset of the gun bore from the axis of the sighting optics when viewing the target; conventionally vertical parallax and horizontal parallax are determined separately.) Most subcaliber devices are unacceptable on this basis alone.

The Brewster device and the subcaliber device described in TC 17-12-6 are designed to reduce or eliminate parallax. Yet any claims should be checked by actual measurements and calculations. The actual parallax with respect to full scale targets would be comparable to a small fraction of an inch with respect to 1/60 scale targets. Another graphic way of stating this is that one inch (at 1/60 scale) equals five feet (60") on the full scale tank, which is far greater than either the vertical or horizontal parallax. The effect of parallax is dependent upon range, compared with the range at which the device is zeroed; if all targets were at the range of zeroing, there would be no problems, but Table VIII involves targets at various distances, which is a distinct departure from the practice with many scalar ranges in the past (which may explain why the parallax problem has not always been apparent in the past.)

The effects of parallax can be assessed by calculating a coefficient of parallax, defined as follows:

$$C = \frac{2P}{D}\left|\frac{T-Z}{Z}\right|$$

where

P = offset of weapon from optical axis (either vertically or horizontally).

D = dimension of target (height or width, for vertical or horizontal parallax respectively.)

T = target distance.

Z = distance of zeroing.

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Whenever this coefficient exceeds 1.0, a round that should hit center of target will actually miss. Certainly that is unacceptable, and such parallax is common in subcaliber devices. It may appear to be impossible to reduce both vertical and horizontal parallax to acceptable levels without obscuring vision, but there are methods for compensation.

The subcaliber device described in TC 17-12-6 recommends aligning the device with the optics so as to eliminate horizontal parallax, and using a cam to compensate for vertical parallax. The Brewster device reduces both kinds of parallax to a minimum without use of a cam, but that minimum appears to be too large. Calculations of the parallax coefficient for the more distant targets illustrates that almost any parallax is unacceptable with a 1/60 scale range.

An alternative suggested here is a device like the Brewster, but aligned precisely under the optics so as to eliminate horizontal parallax. To compensate for vertical parallax, instead of the cam suggested in TC 17-12-6, it is suggested that the rangefinder (RF) and computer be used with an artifical (compensatory) range indexed. A table of such "compensatory ranges" would be needed for the various scaled ranges of targets, based upon firing tests. Since the TC does not range on the 1/60 scale range, the artificial task would be substituted for this actual ranging function. The result should be elimination of parallax effects with a simple, sturdy device, without requiring an extra man for adjustment of a cam.

FOCUS

It has been observed on 1/60 scale ranges that whenever the target is in focus, the reticle is not. Although the reticle is not totally unusable, this is undesirable, and optical compensation should be made. Apparently, this situation can be solved by reducing the aperture of the sight, by means of a cardboard disc with a hole in the center. The reticle pattern seen through the RF is even further out of focus, so it is useless, which makes it impossible for the TC to sense the accuracy of the gunner's aim. This problem also should be solved optically, because the TC is the most important instructional agent for the gunner.

ACCURACY

The basic accuracy (or dispersion pattern) of subcaliber devices is generally worse than for the service rounds, and some are likely to be unacceptable. While no absolute criteria can be stated here, this factor should be considered.

RELIABILITY

It is also important to select a subcaliber device with a mechanism that is reliable, as proven in extensive firing experience (e.g., the M16).

TRAJECTORY

The .22 caliber trajectory has limitations for simulating battlesights gunnery. The trajectory is essentially flat at the ranges involved, compared with the rounds it simulates. Since the form of the trajectory is the basis of battlesights gunnery, the hit/miss feedback will not closely simulate service ammunition for that mode of firing. This would systematically encourage the use of precision gunnery on all engagements, in order to get a higher percentage of hits. Furthermore, the simulation favors precision gunnery, i.e., aiming at center of mass, for another spurious reason: inaccuracies due to ranging error are eliminated, since ranging is not involved on scalar ranges. However, emphasis on precision gunnery is not considered a serious shortcoming.

Battlesights gunnery could be simulated, if desired, by indexing a compensatory factor into the RF, as is suggested above to correct for vertical parallax. However, a different compensatory factor would be involved, and the engagement would have to be designated a battlesights engagement rather than leaving the choice to the TC.

LEADING TARGETS

The gunner must hold a lead on moving targets, depending upon the speed of projectile; the correct simulation would be the same speed as the projectile simulated. The speed of the .22 caliber round differs from both HEAT and SABOT, so the gunner will have to adjust his lead by a compensatory factor, based upon the relative speed of the rounds. It seems that the simulation will be adequate (though undesirable) for training, if the gunner is trained to compensate for the difference in lead. (Holding a lead is not precise adjustment, compared with the visual mass of a tank.)

SENSING OF ROUNDS

The appearance of impact of .22 caliber rounds at 1/60 scale is substantially different from that of service rounds, but there seems to be no reason to suppose that there would be adverse effects (negative transfer of training). It may supplement other BOT practice. There is tracer ammunition available on the German economy, and this appears to add realism to the general impression, and may aid sensing, without adverse effects.

MOVING PLATFORM

Ranges at 1/60 scale do not provide for firing in the stabilized mode. However, rarely are targets of Table VIII engaged in this mode, in fact, although it could be argued that this is an important skill on the modern battlefield.

APPENDIX B VALIDATION AGAINST LIVE FIRING

The various tests that constitute Simulated VIII (S8) have different kinds of relationships to the skills and criteria of Table VIII (live firing). These relationships should be considered when validating the tests. One would expect high correlations only if a function is directly related to a criterion, even if the analysis and test design are valid. Only a few of the functions tested in S8 relate directly to accuracy with the main gun. The other functions were included in S8 because they were essential steps in the engagement process, e.g., target acquisition. These functions are more directly related to performance time than to accuracy, although extreme shortcomings would occasionally result in not hitting targets.

TASKS DIRECTLY RELATED TO ACCURACY

Tasks in S8 that are directly related to accuracy with the main gun are: the engagement tasks (Stations 4 and 6), aiming (Station 2, part 1), tracking (Station 2, part 2), and ranging (Station 3, part 3). Accuracy is the main scoring criterion on these tasks. Performance time, when specified in the standard, is more to ensure smooth, skillful technique than to hurry the action.

ENGAGEMENT TASKS

Subcaliber (1/60 Scale)

Firing the engagements on the 1/60 scale range (Station 4) is designed to be the most complete simulation of the total task that is feasible at the LTA. Therefore, number of hits on this task should correlate with main gun hits. It is assumed that the simulation problems discussed in Appendix A will be resolved. Otherwise, the simulated task could be confusing, if gunners miss when they should hit, and vice versa. Also, these engagements do not involve ranging, which is another skill that affects accuracy directly.

Moving Tank Range

The moving tank range (Station 6) is also supposed to involve accuracy (with M55 laser) although it is primarily a test of procedural skills, because the procedural skills are not otherwise tested.

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CRITICAL FUNCTIONAL SUBTASKS

Two of the subtasks tested on S8 are directly involved in accuracy: aiming at stationary targets (Station 2, part 1) and ranging (Station 3, part 3). Both functions directly affect pointing of the main gun on most hard targets. Each should correlate substantially with main gun hits in live firing. These are relatively homogenous functions that can be readily tested, so test reliability coefficients are expected to be high.

LESS CRITICAL SUBTASKS

Tracking moving targets (Station 2, part 2) also affects accuracy. However, Table VIII contains only two moving targets, so the tracking scores are not likely to correlate highly with total accuracy. Higher correlations would be expected when only the moving targets are considered. It is possible that tracking involves almost the same skills as aiming at stationary targets, in which case both should correlate with main gun hits.

TASKS RELATED TO SPEED

Opening time and total course time are most likely to be affected critically by those functions that would prevent engaging a target, either temporarily or permanently, if not performed adequately, e.g., not detecting a target. The resulting delays would generally be much greater than anything that would result from marginal skill in such functions as aiming or ranging.

The nature of these delays may also make correlational studies difficult. The delays are apt to be occasional events, but with substantial time involved in each instance. The expected result would be erratic performance time data, especially on Table VIII, which would tend to obscure any relationships that exist.

It is also difficult to reconcile speed and accuracy criteria, not only in S8, but also in live firing. Although the importance of speed is stressed in FM 17-12 and in gunnery training, current Table VIII qualification standards do not particularly encourage speed. Rarely is a crew rated red (not qualified) on the basis of speed alone. The ambiguous status of time criteria is likely to continue, complicating efforts on validation.

CRITICAL FUNCTIONAL SUBTASKS

Target Acquisition

The time taken to detect and report targets is tested on Station 3, part 1. This function requires a substantial part of the time taken to open on a target, so the test should correlate with opening time. However, this function is generally circumvented, at least partially, by crews knowing about the course in advance from other crews that have already had Table VIII. This function will also critically affect target hits in those rare instances where a crew never detects a target.

Laying Main Gun (Station 3, part 2)

This function, performed by the TC is involved in engaging virtually every target. (An exception occurs when the target happens to appear in the gunner's infinity sight without laying the gun.) This is a rather difficult skill, and it could consistently shorten (or prolong) the time it takes the gunner to identify targets (unlike detection, where time savings are more apt to be sporadic, but substantial when they do occur.) This function is more apt to correlate with opening time than with total time, because of the various other functions involved in total time.

Laying Main Gun (Station 5, part 1)

Since this applies only to reloading on Table VIII one should not expect it to correlate with opening times. Only a very modest correlation with total time could be expected at best, because of the other functions involved.

PROCEDURAL SKILLS

The procedural aspects of each engagement are represented in the tasks at Stations 4 and 6 (scaled ranges). The procedureal aspects are a matter of what actions are performed by the various crew members, rather than the skill in performing them. Station 6 especially has been included to represent procedural items, including moving from one engagement to another. These tasks should correlate somewhat with both total time and opening time, although it is quite possible that the (rather simple) procedures are so well learned by all crews that any relationship is obscured, i.e., a "test ceiling" effect. In rare instances, procedural mistakes may cause a crew to miss a target, e.g., wrong ammo indexed but such instances are apt to be so rare that substantial correlation is not expected.

Procedural skills present special problems for correlational studies because they are so easily learned. At the time of gunnery, almost all crews are likely to be at such a high level of performance that no correlation will be evident. Yet between events at the MTA, crews are apt to become slow and sloppy if they do not expect a test. The function of testing procedural skills at the LTA is to ensure the needed amount of repetitive practice (however brief that may be in terms of training hours.)

The driver tactical response (Station 5, part 1) may also correlate with opening time, but only modest correlations would be expected because of the other functions involved.

CONTINGENCY TASKS

The immediate action tasks (Station 4, parts 2, 3, and 4) may correlate with opening time or total time. But the corresponding malfunction must first occur for these skills to be used, so low correlations would be expected.

ENABLING SKILLS

Certain functions in S8 are a part of other performances, but are also tested separately for efficiency and diagnostic power. For example, estimation of lead (Station 1, part 1) permits determination of whether a gunner or TC knows what lead to hold, so that any errors of estimation can be corrected quickly and easily. That will also simplify the diagnosis of any subsequent problems with moving targets. However, one would not expect correlations between estimation of lead and total score on Table VIII, because it applies only to moving targets, and involves only part of the performance.

Similarly, adjustment of fire (Station 1, part 2) is not likely to correlate highly with total performance, because it applies only to second rounds, and it is only a part of the performance. Applying data from a range card (Station 2, part 3) is a handy way to check a basic function. But substantial correlation with performance on range card engagements would not be expected, unless a substantial number of crews could not perform to standards.

APPENDIX C ALTERNATE SCORING SYSTEMS

As the various tests of S8 are put into practice, modification of the scoring may be necessary or desirable. Sometimes standards may be unrealistically high or low. More critical aspects of performance may become apparent. Some features of scoring may prove to be unnecessarily clumsy. Some tests may be weighted more heavily because they correlate with the criteria. This section presents some of the considerations involved.

MODIFICATION OF PARTICULAR TEST STANDARDS

SUBCALIBER RANGE (Station 4)

The standards on the 1/60 scale ranges were developed to apply separately to each engagement, so that crews could concentrate remedial practice on those engagements on which they performed poorly. This presumes that different engagements involve different skill factors (an assumption which may be only partially valid.) In order to get reasonably reliable scores on each engagement, three (or more) repetitions were required. The advantages of that scoring system now appear dubious.

A promising alternative would be to score the whole exercise as a unit, applying the standards of Table VIII. The major advantage of that alternative would be to cut testing time and effort to about 1/3, while still providing reliable test data (each score being based upon many engagements.) The test scores might correlate better with Table VIII performance, since the same scoring systems are involved. On the other hand, the diagnostic value of a score for each engagement would be lost. The importance of this consideration will be indicated by experience. Perhaps problems can be diagnosed as well on the basis of hit and miss data, and considerations of crew actions.

Another promising alternative would be to score the day and night activities separately, so that remedial practice and possible retesting could be done immediately. This method would also have most of the advantages of scoring the whole exercise as a unit like Table VIII. The required hits and first round hits of Table VIII would be allocated to the day and night runs, keeping the proportion of hits approximately the same. Thus, standards for an amber rating could be 4 out of 7 daytime targets hit, with three first round hits, and 3 out of 4 night targets hit, with two first round hits (compared with Table VIII standards of 7 out of 11 targets hit, with five first round hits).

MOVING TANK RANGE (Station 6)

The special function of this station is to provide a check on procedural aspects of performance. There probably should be a check on procedural items performed, e.g. correct ammunition indexed, which should be observed inside the tank. There may have to be some relaxation of accuracy standards with the laser, if compromises make this an inadequate test of gunnery. There may also be a tightening of time standards, especially if some aspects are eliminated or abbreviated.

If the recommended training conditions are not maintained and performance or efficiency appears to suffer, it may be desirable to establish the initial training (with stationary tank) as a separate part of S8. This could be done conveniently at Station 2 by making it part 4, since the conditions of simulation are very much like Part 1. That would also direct attention to efficient conditions for practice.

AIMING, STATIONARY TARGETS (Station 2, part 1)

The standards and conditions for this function will warrant special attention, because of its criticality in relation to Table VIII standards. Normative data would indicate whether the standards are unrealistically strict or lenient. Rather strict standards are desirable. There should also be attention to the adequacy of simulation, e.g. alignment of projected beam with the sight reticle, to ensure that it is the accuracy of perceptual-motor control that is being tested, rather than some kind of error variance in the system.

RANGING (Station 3, part 3)

Ranging is another skill that is critical to accuracy and therefore should receive special attention. There should be an even dispersion of targets ranging from 1000 to 2000 meters. Sharpness of contour (especially vertical edges) should be typical of real targets. It has been suggested that various means be employed to simulate haze or fog, e.g. covering with a tarpaulin, but that simulation may be unrealistic; it would be desirable to determine this experimentally. It would also be desirable to know how visual acuity relates to this skill, and what performance increments could be expected if visual selection standards were instituted.

MODIFICATION OF SUMMARY SCORING

Qualification on S8 (as stipulated above) requires crews to qualify on all parts at all stations. That may be unrealistic in practice, and experience during validation should yield indications of appropriate adjustments in ways to combine the scores of the various parts.

BASIC ASSUMPTIONS

The requirements to pass all tests is based upon the philosophy of training to meet the standards, which is classic training strategy. In practice, the feasibility, even the desirability, of that requirement rests upon the assumption that:

(1) the standards are realistic
(2) the tasks are valid
(3) repeated testing and adjustment of training schedules is practicable.

Standards are unrealistic if few can achieve them. But, they should be high enough to require a level of skill needed in combat. Sometimes the necessary level will be rather easy to achieve, but sometimes it may take considerable practice.

Validity of tasks may be indicated by analysis, i.e., criterion referencing, which was the objective in this paper. But it is preferable to have tasks that also correlate with performance on Table VIII, especially if substantial practice is required to meet the standards.

Repeated testing and adjustment of training schedules often involves practical constraints. Sometimes testing involves considerable time and facilities, e.g. the subcaliber engagement tasks at Station 4, although such experience also serves as practice. The difficulty is that many crews will fail on some tests, without enough opportunity to make up their deficiency. Also, repeated testing may entail statistical problems, in that sooner or later a test may be passed by chance, that is, luck.

A TRADITIONAL APPROACH

The traditional approach to these problems is somehow to average the scores on various parts of the test, perhaps weighting some parts more than others, to come up with a composite score. But the "averaging" approach begs the question of whether each function is really needed. As a result, too many skills are apt to be tested, and the really critical skills are apt to be slighted. Also, it is generally difficult to justify any particular weighting scheme.

COMPROMISES

Probably some compromise scoring system will be needed for S8 qualification, at least on an interim basis. Crews should be required to pass each of the tests that seem to meet the assumptions of the train-to-standards model. On the other tests, some kind of composite score would be required. The scores on these tests might be weighted according to some estimate of importance in the engagements.

Probably ranging and aiming tests should be in the "required" group, especially if these test scores correlate with performance on Table VIII. If they do not correlate, one should first consider the adequacy of the simulation and testing conditions, because it is difficult to imagine that these functions are unimportant in gunnery, or that everyone is equally skillful. The test conditions for these functions are sufficiently simple so that repeated testing should be feasible.

The subcaliber firing (1/60 scale) probably should also be in the required category, assuming that the problems of simulation and scoring can be resolved (as is anticipated). Considerably less retesting is feasible than with some of the simpler functions.

Target acquisition is a particularly difficult function to evaluate in qualification. It is of critical importance in battle, yet of dubious relevance to Table VIII, especially for accuracy. Training and testing conditions involve several practical difficulties. No easy resolution of these problems is anticipated.

The other tasks of S8 are somewhat less directly relevant to the criteria of Table VIII. Empirical data will be useful in sorting these tasks into the "required" or the "aggregate" categories of tests.

APPENDIX D PROTOTYPE DEBRIEFING FORM

PART 1. INITIAL CONDITIONS OF TANK AND CREW

Tank ID_____

Initial conditions, problems (describe):

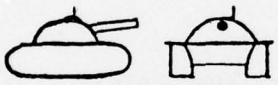
1. Mechanical

2. Crew's vision, physical condition.

3. Firing range (weather, dust, etc.)

4. Other?

PART 2. TARGET ENGAGEMENT EVENTS, DIAGNOSIS (One For Each Target)

	Target ID _____	
Opening Time	_____ sec.	
Round Sequence Control Off. Sensings		
Conditions	Ammo_____ ☐ NBC ☐ Btnd. Up ☐ Defilade	
Detection Problems?	explain	
Detection	☐	
TC Lay	☐	
Gnr. ID	☐	
Other----	☐	
Opening Slow? Why?		
RF Used?	___ ___ ___	
Rng. Indexed	___ ___ ___	
Sight Used	___ ___ ___	
Aiming Point (+)		
Mode (Pre., BS, Other)	___ ___ ___	
Crew Sensing	TC: TC: TC: G: G: G:	
Adjustment Technique	Other _____ ___ ___ ___	
Mechanical, Other Problems		
Diagnosis: (What caused round to miss)		

PART 3. INTERVIEW SUMMATION

Prescription:

1. What training or maintenance might remedy the problems that have been diagnosed?

2. (Table VII only) What can be done to correct the deficiences before Table VIII?

3. What are the implications for the unit's training program?

4. What problems were encountered in administering the test?